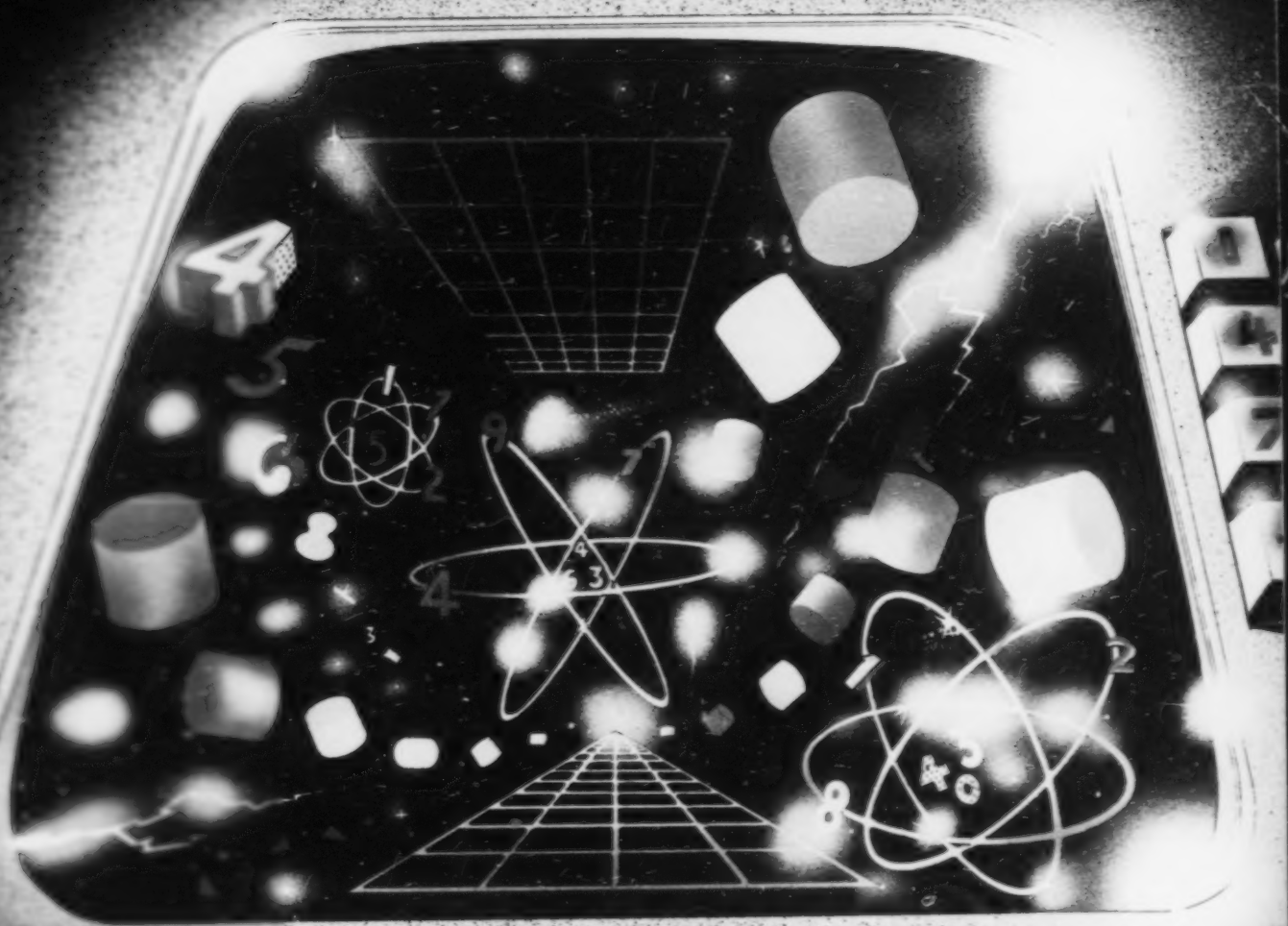
C8650-1A

DATAMATION

INTERNATIONAL EDITION AUGUST 1 $3 © TECHNICAL PUBLISHING



THE ON-LINE TRANSACTION PROCESSING WORLD

TOOLS FOR DEVELOPING OLTP APPLICATIONS

BACK OFFICES ON BACK ROADS

DATAMATION

AUGUST 1, 1985/$3 U.S.A.
VOLUME 31 NUMBER 15
This issue, 192,650 copies

FEATURES

22
IN FOCUS
Many companies are finding the low rents and still open spaces outside the city very attractive. Robert M. Garsson reports that for MIS, too, it makes sense if "Dp Goes Suburban."

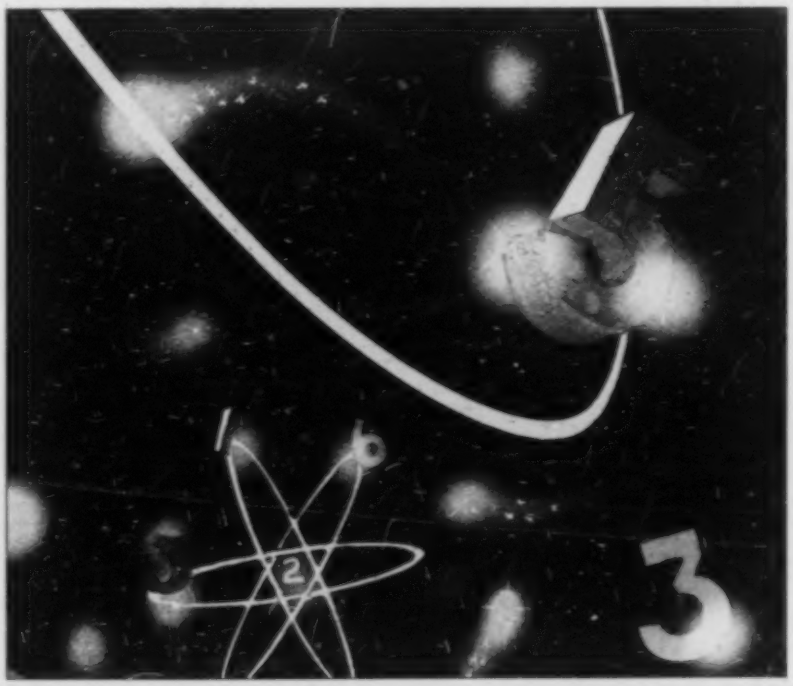
60
EXPLORING THE OLTP REALM
Omri Serlin
From airline reservation systems to financial applications—everything you thought you knew about OLTP and more.

73
TOOLS FOR DEVELOPING OLTP APPLICATIONS
Lawrence A. Rowe
Fourth generation languages and other development aids make it easier to develop transaction processing systems in lower-performance environments. Before long, these same tools will be available for high-performance systems.

86
INFORMATION POLITICS
Mark Klein
The modern corporation has a pressing need to aggressively and appropriately apply information technology.

97
POWER AND CREDIBILITY IN OFFICE AUTOMATATION
N. Dean Meyer
Office automation is a politically parlous endeavor. So why coerce people when you can persuade them with results?

127
READERS' FORUM
It is a fact in today's highly mobile corporate world that learning new systems has become a way of life. It is also a fact that most data processing departments don't have the time to provide continuous staff training. So, how are new users trained? Through the highly unstructured but often productive system known as "Oral Tradition," says Mark Hall.



NEWS IN PERSPECTIVE

32 **INTERNATIONAL**
Russia's five-year cpu plot.

34 **SOFTWARE**
Time to drop anchor.

39 **NETWORKING**
Hey dad, where are you?

46 **SUPERCOMPUTERS**
Straight and narrow.

52 **MICROCOMPUTING**
Late to school.

56 **BENCHMARKS**

DEPARTMENTS

9 **LOOK AHEAD**
15 **LETTERS**
19 **EDITORIAL**
105 **PEOPLE**
111 **HARDWARE**
117 **SOFTWARE**
123 **SOURCE DATA**
128 **ADVERTISERS' INDEX**

INTERNATIONAL 56-1

-4 **EUROPE'S 1984 VINTAGE**
-15 **NEW SHADES OF BLUE IN EUROPE**

COVER ILLUSTRATION BY ANDREA BARUFFI

DATAMATION rates the most fruitful firms in a maturing market.

EUROPE'S 1984 VINTAGE

by Paul Tate and Linda Runyan

Savoring the sweet taste of success, Europe's leading data processing companies reaped bountiful revenues last year from a market that's steadily maturing. Growth was good in 1984 for these fruitful firms that harvested combined revenues of $28.3 billion, up a hearty 9.7% in dollars.

IBM, the champagne of companies, leads the list of top 25 firms, despite results that were less than sparkling last year. The dp giant still had an easy climb to the top of the vendor vine, with European revenues that were more than five times higher than its closest rival, West Germany's Siemens. The DATAMATION survey also shows a sharp falloff of $272.7 million in revenues between NCR, which ranks 13th, and Wang, which holds the number 14 position. The dozen dpers that come below Wang are closely clustered together on the table that cuts off at Data General, which pulled in European earnings of $220.1 million. That cutoff point was much higher last year than it was in 1983, when DG was also in the cellar, with a turnover of $163 million.

The 1984 European 25 survey was compiled exclusively by DATAMATION from information culled from an in-house database that tracks the dp results of over 200 companies thoughout the world. This expanded database enables DATAMATION to present a more accurate picture of the best performers in the European market. Some 1983 figures have therefore been restated and appropriate adjustments made in the rankings.

Making the biggest jump on the European 25 table was Hewlett-Packard, which moved up four notches to seventh place. Taking the biggest dive was Britain's ICL, which dropped down four slots to number 10. Overall, there was little change in company positioning, with most firms staying approximately in the same spots they held in the 1983 survey. In fact, six of the 25 winners captured the exact same ranks they achieved in 1983.

The total European dp revenues were, of course, much higher in 1984, reflecting the general upturn in European economic conditions over the year. The expansion of the European economies was slow but steady, with national growth rates hovering at around 2%. That upswing, though modest, had a big impact on the dp industry, which benefited from more widespread spending on computers and communications wares.

Spending was particularly strong in the microcomputer sector, so strong that Commodore, with European sales of $406 million, and Apple, with revenues of $315 million, were able to enter the ranks of the top 25 in 1984. Business was very good for Commodore in France, in West Germany, and even in Olivetti's backyard, Italy, where earnings were up over 1,000%. Sales were more sluggish in the U.K., where Commodore had much stiffer competition.

Big Blue also took advantage of the European micro movement. The PC, which became the best-selling microcomputer on the European scene, helped IBM boost its sagging revenues. The company's puny 5.9% increase resulted in European dp revenues of roughly $11 billion, which represents 39% of the combined revenues of the top 25—a weaker position than in previous years. Nevertheless, the percentage of revenue that IBM Europe contributes to corporate earnings is continuing to shrink. Last year its European business accounted for 25% of worldwide revenues, compared with 42% back in 1979.

IBM's European subsidiaries, however, still recorded good growth gains in

PHOTOGRAPH BY TOGASHI

terms of local currencies. IBM U.K. was up 40%, IBM Italy 20%, and IBM France 19%. IBM Germany, which posted a scant 6% increase, was the notable exception. Big Blue's biggest breadwinner in Europe, IBM Deutschland, saw profits slump to $260,000 in 1984.

DROPOUTS AND DEBUTS Another mighty U.S. multinational, ITT, dropped off the top 25 table this year, despite a hefty 20% hike in European dp sales to $200 million. Also absent from the league of leaders were France's Thomson-CSF and American pcmer Amdahl. Business was a lot better for Europe's leading pcmer and magnetic media mogul BASF, which made its debut in DATAMATION's European 25 survey. The West German firm derived $134 million of its $298.2 million in total dp sales from peddling Hitachi mainframes and peripherals. Most of those sales came from Germany, the U.K., and France.

Minicomputer makers also did well in Europe last year. In fact, Digital Equipment did so well that it was able to move up one notch in 1984. DEC's arch rival, Data General, staged an impressive comeback in both Europe and the States. The Massachusetts mini manufacturer registered a 34% spurt in European revenues, compared with a dismal 4% in 1983. And while business is looking a little bleaker this year for the company in its homeland, DG is expected to garner healthy sales in Europe, where its CEO office automation wares have scored big points.

DG's sales surge puts it on DATAMATION's list of fastest growers in Europe (Fig. 1). Also on that table are four companies that didn't make the 1984 European 25—Norway's Norsk Data, Italy's Finsiel, Britain's Scicon, and France's Cap Gemini Sogeti. Norsk Data's 54% boost in European dp revenue to $142 million reflects the mini maker's continuing dynamic growth. The mushrooming micro market in Europe last year also accounts for the phenomenal revenue gains of U.S. micro firms Commodore and Apple, which posted jumps of 92% and 75%, respectively. Both are newcomers to DATAMATIONS's European 25.

With the exception of ICL, which posted an increase of only 8.3%, the slowest growers were all American companies. In that stunted growth group were NCR, up 1%; IBM, up 5.9%; Control Data, up 7%; and Honeywell, up 9.5%. The U.S. firms were clearly hurt by the strong dollar. The steep currency slide also took the edge off the earnings of European companies when measured in dollars. The currencies most affected by the bubbling dollar were the

FIG. 1
FASTEST GROWERS IN EUROPE

ERP. 25 RANK	COMPANY	% CHANGE IN AAC	ERP. DP REV. ($ MIL.)
15	Commodore	92.4	406.6
18	Apple	75.0	315.1
37	Norsk Data	53.7	141.7
31	Finsiel	43.2	156.0
36	Scicon	41.4	142.1
14	Wang	37.3	435.7
24	Ferranti	36.5	226.6
7	Hewlett-Packard	36.2	992.0
25	Data General	34.4	220.1
34	Cap Gemini Sogeti	30.4	150.4

FIG. 2
LEADING EUROPEAN DP COMPANIES

	COMPANY	COUNTRY	WORLDWIDE DP REV. ($ MIL.)	% CHANGE IN AAC
1	Siemens	W. Germany	2,789.5	10.6
2	Olivetti	Italy	2,012.4	28.2
3	Bull	France	1,555.6	16.8
4	ICL	U.K.	1,222.7	8.3
5	Nixdorf	W. Germany	1,147.4	20.7
6	L M Ericsson	Sweden	1,123.3	24.7
7	Philips	Netherlands	1,090.3	12.2
8	Triumph-Adler	W. Germany	631.6	15.0
9	Racal	U.K.	525.8	30.0
10	Mannesmann Kienzle	W. Germany	343.0	21.3
11	BASF	W. Germany	298.2	21.4
12	Plessey	U.K.	290.0	14.8
13	Thorn EMI	U.K.	267.3	28.2
14	Ferranti	U.K.	266.0	36.2
15	Rank Xerox	U.K.	236.0	30.1
16	Cap Gemini Sogeti	France	206.0	28.6
17	Nokia	Finland	181.0	28.8
18	Scicon	U.K.	173.3	41.4
19	Cisi	France	171.6	16.0
20	Norsk Data	Norway	166.7	53.7

METHODOLOGY

For this survey, Europe includes Austria, Belgium, Denmark, Finland, France, West Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, and the U.K. The survey definition of data processing includes mainframes, minicomputers, microcomputers, office systems, data communications, peripherals, software and services, and maintenance and repair. Excluded are data transmission from specialized common carriers, electronic and mag card typewriters; electronic cash registers; instrumentation devices; test equipment; semiconductors; printed circuit boards; and dp supplies, except for magnetic media for disks and tape drives. For computer-based manufacturing systems, such as computer-controlled machine tools, only the computer and hardcopy output devices are included.

All revenue and earnings figures have been adjusted to calendar year calculations. All the European company figures were converted to U.S. dollars, using OECD exchange rates. The main table shows growth rates in actual accounting currencies (AAC) to compensate for fluctuating exchange rates. For accuracy, some 1983 figures have been restated and appropriate adjustments made in the rankings.

THE DATAMATION EUROPEAN 25

1984 RANK	1983 RANK	COMPANY	HEAD-QUARTERS	1984 ERP. DP REV. ($ MIL.)	% CHANGE ($ MIL.)	% CHANGE (AAC)
1	1	International Business Machines	U.S.	10,984.4	5.9	5.9
2	2	Siemens AG	W. Germany	2,092.1	4.5	16.8
3	4	Ing. C. Olivetti & Co. S.P.A.	Italy	1,504.6	6.2	23.1
4	5	Digital Equipment Corp.	U.S.	1,464.1	29.0	29.0
5	3	Groupe Bull	France	1,440.5	1.8	16.8
6	8	LM Ericsson	Sweden	1,011.0	15.6	24.7
7	11	Hewlett-Packard Co.	U.S.	992.0	36.2	36.2
8	7	Nixdorf Computer AG	W. Germany	975.3	3.1	20.7
9	9	Burroughs Corp.	U.S.	967.5	12.5	12.5
10	6	ICL	U.K.	917.0	−4.6	8.3
11	10	N.V. Philips Gloeilampenfabrieken	Netherlands	839.5	−.4	12.2
12	12	Sperry Corp.	U.S.	799.0	13.0	13.0
13	13	NCR Corp.	U.S.	707.7	1.0	1.0
14	15	Wang Laboratories Inc.	U.S.	435.7	37.3	37.3
15		Commodore International Ltd.	U.S.	406.6	92.4	92.4
16	14	Control Data Corp.	U.S.	375.0	7.0	7.0
17	16	Mannesmann Kienzle GmbH	W. Germany	343.0	8.5	21.3
18		Apple Computer Corp.	U.S.	315.1	75.0	75.0
19	18	Honeywell Inc.	U.S.	310.2	9.5	9.5
20	17	Plessey Co. plc	U.K.	290.0	1.0	14.8
21	19	Thorn EMI plc	U.K.	242.7	12.7	28.2
22	21	Rank Xerox	U.K.	236.0	14.6	30.1
23		BASF	W. Germany	228.1	8.6	21.4
24	22	Ferranti plc	U.K.	226.6	19.8	36.5
25	25	Data General Corp.	U.S.	220.1	34.4	34.4

NA: NOT AVAILABLE

Italian lira, down 15.7%, the French franc, off 14.7%, and the British pound, down 13.7%. Most of the other European currencies, including the German mark, fell by about 12%.

Once again the U.S. vendors dominate the field, winning 12 slots on the European 25 table. The European contingent includes five U.K. companies, four German firms, and one company each from France, Italy, the Netherlands, and Sweden. Among the five frontrunners are two American firms, IBM and DEC, which also hold the number one and number two positions in the DATAMATION 100 (see "A Global Industry. The DATAMATION 100," June 1, p. 36).

Coming in a distant second to IBM is Germany's giant, Siemens, which is followed by Italy's national dp hero, Olivetti. Falling two notches below Olivetti is France's dp flagship, Bull, which dropped two places in the 1984 ranking.

All of these national dp powerhouses earned top positions on DATAMATION's list of leading European companies that are ranked by worldwide dp revenue (Fig. 2). Seven of those firms are not included on the main table because their European dp turnover falls below the $220 million cutoff point.

The companies in this category are Triumph-Adler, Racal, Cap Gemini Sogeti, Nokia, Scicon, Cisi, and Norsk Data. The inclusion of Cap Gemini Sogeti, Scicon, and Cisi in that worldwide leadership league reflects the expansion of the European software and services market. Last year revenues in that market rose 20% to roughly $13 billion.

Last year Thorn EMI, which gets most of its revenues from software and services, chipped in $133 million for chip maker Inmos and took over software house EPS Consultants. This teamup trend was very much in evidence in Europe last year, especially in the telecom field. In March AT&T, through its corporate arm around Olivetti, took a 25% stake in the born-again Italian office systems company. In Denmark ITT acquired the financially troubled Christian Rovsing, while in Britain, Standard Telephone & Cables took over ICL for $540 million in August.

MERGING OF TWO BEHEMOTHS

The Dutch Philips would also have made a major acquisition if it could have found a suitable mini maker to prop up its product line. Instead, it spent the year forging links with Control Data to market optical storage systems and with Siemens to develop new semiconductor technology under the Mega project.

Like Siemens, Philips is a huge electronics group that has traditionally been about as streamlined as a brontosaurus and about as fast to react to change. Both behemoths have overhauled their operations, merging their computer and communications divisions. While Siemens is pinning its hopes on its Hicom PBX, Philips is counting on its Sophomation (Synergistic Open Philips Office Automation) net products that are based on open networking concepts.

Rallying around the International Standards Organization's open systems in-

TOTAL DP REV. ($ MIL.)	% CHANGE ($ MIL.)	1984 TOTAL REV. ($ MIL.)	ERP. DP REV. AS % OF TOTAL DP REV.	DOM. REV. AS % OF TOTAL DP REV.	DP REV. AS % OF TOTAL REV.	NET INCOME ($ MIL.)	1984 EMPL.	FISCAL YEAR END
44,292.0	21.3	45,937.0	24.8	59.6	96.4	6582.0	394,930	Dec
2,789.5	−1.1	16,076.8	75.0	55.0	17.3	374.0	319,000	Sept
2,012.4	10.7	2,605.6	75.0	39.5	77.2	202.6	47,613	Dec
6,230.0	29.0	6,230.0	23.5	65.0	100.0	487.0	88,600	June
1,555.6	1.8	1,555.6	92.6	63.4	100.0	−55.9	26,435	Dec
1,123.3	15.6	3,545.1	90.0	28.0	31.6	53.7	70,000	Dec
3,400.0	36.2	6,297.0	29.2	61.0	53.9	665.0	80,000	Dec
1,147.4	7.9	1,147.4	89.0	49.0	100.0	42.4	20,190	Dec
4,500.0	12.5	4,875.6	21.5	59.0	92.3	244.9	65,000	Dec
1,222.7	−4.6	1,222.7	75.0	57.0	100.0	18.7	15,167	Dec
1,090.3	−0.4	16,766.0	77.0	12.5	20.8	346.0	344,000	Dec
3,473.9	13.0	5,370.0	23.0	70.0	64.7	267.6	77,000	Mar
3,670.0	10.1	4,074.3	21.0	55.7	90.0	342.6	62,000	Dec
2,420.7	35.0	2,421.1	18.0	71.2	99.9	230.7	30,000	June
1,129.5	21.8	1,189.5	34.2	60.0	94.9	100.3	NA	June
3,755.5	7.0	50,269.9	10.0	82.0	74.7	31.6	54,100	Dec
343.0	8.5	428.1	100.0	79.0	80.1	104.3	8,000	Dec
1,897.9	74.9	1,897.9	16.6	78.0	100.0	104.3	5,382	June
1,825.0	9.5	6,073.6	17.0	74.0	30.0	239.0	94,300	Dec
290.0	1.0	1,953.1	100.0	68.0	14.8	127.9	38,838	Dec
267.3	7.3	3,761.2	90.8	82.0	7.1	120.8	91,544	Mar
236.0	14.6	2,353.3	100.0	NA	10.0	112.0	31,000	Oct
298.2	8.6	12,392.0	76.5	NA	2.3	NA	31,000	Dec
266.0	19.8	666.7	85.0	74.0	39.8	38.4	11,087	Dec
1,229.7	40.9	1,229.7	17.9	70.1	100.0	78.4	17,695	Sept

terconnection (OSI) standards, the major European firms banded together last year to fight their fiercest competitor, IBM, and its SNA networking solution. Among the OSI support group are Philips, Siemens, Olivetti, Bull, Ericsson, Nixdorf, and ICL.

Three of these OSIers—Bull, ICL, and Siemens—also joined forces last year to form the European Computer Research Center (ECRC), which will explore artificial intelligence (AI) research. The group hopes this research will result in products that they can use to protect their home markets, which have been dented by Big Blue. So far, however, ECRC progress has been slow, due to personnel shortages and the mutual indecision of the three sponsors.

The various national AI research projects also began to get under way last year. There was Alvey in the U.K., Konzept in Germany, and sundry research schemes in France. The European Economic Community (EEC) also ended the pilot phase of its $1.5 billion Esprit program, which is 50% funded by European governments. With one high-profile project under its bureaucratic belt, the EEC is now working on another ambitious effort, the Research for Advanced Communications in Europe (RACE) program. The purpose of the plan is to develop a Europeanwide integrated services digital network (ISDN), which will help standardize telecom equipment and open up PTT-protected markets.

Such schemes are not only aimed at building local technological muscle, they are also designed to foster the concept of a united Europe. While these programs promise numerous benefits in the long run, in the short term they do little to help local firms that are finding it tough going in the European market.

Companies around the world are seeking new markets and new technologies and techniques to penetrate those markets. Foremost on that list are Japanese vendors. Still absent from the top 25 rankings, Japanese companies have gone the partnership route in Europe. Last year Bull signed a deal to distribute NEC's high-end mainframes. Meanwhile, BASF and Olivetti have been peddling Hitachi mainframes for years, and both ICL and Siemens have been selling big Fujitsu systems. In fact, Fujitsu was working with ICL last year to develop two new mainframe lines. The Japanese company also took a majority stake in Spanish dp firm Secoinsa in 1984.

The Japanese have yet to make any direct inroads into the European dp domain. Given their export drive and marketing skills, it may only be a matter of time before they come knocking on Europe's front door. The Americans, and certainly IBM, are already there. That Yankee contingent may be missing two members next year, since both Commodore and Apple may fall off the European top 25 chart as a result of slumping micro market sales.

Economic and market conditions could also turn things sour for European dp companies. Feeling the squeeze from vintage vendor IBM, these homegrown firms proved this year that they will not settle for the dp dregs in Europe. Next year's DATAMATION European 25 survey will show just how successful they've been in harvesting those hopes.

A look at the expanding universe of on-line transaction processing applications.

EXPLORING THE OLTP REALM

by Omri Serlin

Sophisticated market research is not required to convince anyone that computers are deeply ingrained within the structure of today's business enterprises. It has become nearly impossible to complete a business transaction without the involvement of some computer somewhere. One has only to think of one's latest interaction with a travel agent, bank teller, automatic teller machine, telephone directory assistance operator, or retail store clerk to realize how far this process has progressed.

Since the mid-1960s, on-line applications have been consuming a progressively larger share of the processing power represented by all new shipments of mainframe and medium-scale computers. The proportion of such systems intended exclusively or partially for on-line work is already well over 50% by some estimates, and is projected to reach 75% before the end of the decade.

On-line transaction processing (OLTP) is the name commonly used to describe applications in which a common database is available to interactive terminal users for both inquiries and updates. The database in such applications is a representation of some aspect of the business; a transaction is a representation of an activity (e.g., receipt of an order) that may transform the database from one state to another, or which may result in merely displaying some information about the state of the business.

OLTP is fundamentally different from the so-called interactive computing or the timesharing systems of the 1960s and 1970s—although, with users hunched over terminals, it does resemble them superficially. Timesharing systems attempt, through architectural artifices and specialized operating systems, to create the illusion that each user has access to a completely independent, private computer. OLTP systems, on the other hand, are created explicitly to allow concurrent, on-line sharing of common databases by multiple users.

Unlike early users of timesharing systems, who would probably be regarded today as hackers or computer technology enthusiasts, most users of OLTP systems regard the computer as a business tool and care little about the underlying technology. This is key to the expansion of the OLTP market—just as the dramatic expansion of the desktop microcomputer market occurred when business software supplanted kits for tinkerers.

The earliest large-scale OLTP systems were the airline reservations systems of the mid-1960s, which were expanded later to include such functions as crew and equipment scheduling. In the mid-1970s came other reservation systems for hotel/motel and car-rental agencies; large-scale banking applications, such as demand/deposit teller support, automatic teller machines (ATMs), and electronic funds transfer (EFT); credit authorization systems; and trading and brokerage systems.

Today, the acceptance of OLTP systems is rapidly spreading to the manufacturing segment, where JIT (just-in-time) disciplines and paperless factories are dependent on the computer for their minute-by-minute operations. Even such classical back-room functions as billing and inventory control are rapidly being converted to on-line operations with strong OLTP characteristics. Many editorial support systems in large newspapers and magazines have an OLTP flavor, as do some hospital management systems that combine clinical and administrative support.

IBM IS USED BY MOST

By far the majority of OLTP applications today are being implemented with IBM large-scale 308X mainframes (see Fig. 1). The two key software elements usually involved are CICS and IMS. The venerable CICS (customer information control system), despite its age, is still used in nearly 70% of all large IBM installations, according to an August 1984 survey. CICS provides centralized terminal management and applications scheduling for OLTP applications.

IMS, of course, is IBM's main database offering; its data communications (DC) facility is sometimes used to implement OLTP applications. IMS/Fastpath is a specialized, OLTP-oriented database subsystem that offers higher transaction throughput, but at the cost of reduced functionality. Among minicomputer makers, DEC, Hewlett-Packard, and Prime are probably the leading suppliers of transaction processing equipment.

A budding application with substantial (though so far unfulfilled) potential is generically known as videotex. Originating in the U.K., videotex was meant to provide consumers and small businesses access to useful databases (e.g., airline and railway schedules) by relying on an augmented tv set as a terminal, using the public telephone network as the communications medium. Despite a number of promising experiments, the idea never caught on in the U.S., where the popularity of desktop microcomputers preempted the need for the tv set.

Rather than provide for inquiries only, videotex efforts in the U.S. are now focused more on transaction services like home banking. Notable in this respect is the recently formed partnership between Bank of America, Chemical Bank, AT&T, and Time Inc., which plans to offer homes equipped with a personal computer access to banking services, a discount stock brokerage, and teleshopping.

In the telephone system, the computers that now control many central office switches (and indeed those within modern PBXs too) may be regarded as rudimentary on-line transaction processing systems. More complex on-line transaction functions are rendered by the directory assistance systems the operators use and the

ILLUSTRATION BY ANDREA BARUFFI

The airline reservations systems remain the archetype of OLTP applications.

systems that support toll-free calling.

Promising future applications with varying OLTP content include value-added communications networks; support of automatic point-of-sale (POS) retail systems like automated gasoline pumps; and the emerging work group computer or file-server application, where a small multi-user system supports electronic mail functions and possibly other common databases in the office environment (see "Departmental Computing: A Choice of Strategies," May 1, p. 86).

Airline reservations. In many ways, the airline reservations system remains the archetype of OLTP applications: it has to support a large number of users, must allow concurrent updates to a large database, must be up and available around the clock and year-round, and is at the heart of the business its serves.

In an airline reservations system, the common database, representing the inventory of available seats on various flights, is made accessible to travel agents using interactive terminals. The agents can make various inquiries against the database (such as which flights operate between two cities on a given date on or about a given hour, and what class seats are still available). Then the agent can make an actual booking, which involves on-line database updates—reducing the number of available seats on a given flight by the number booked, and creating a related passenger name record (PNR) containing such information as the passenger's name and phone number. A booking cancellation also results in a database update.

Although Sperry Univac was initially a contender in the airline reservations business, virtually all major systems currently in use (American Airlines' SABRE, United Airlines' Apollo, TWA's PARS) use IBM large-scale mainframes. In cooperation with the airlines, IBM developed ACP (Airline Control Program), an operating system specialized to achieve the high transaction throughput required by the reservation application.

ACP, now renamed TPF (for Transaction Processing Facility), is being offered to other industries as well. At the Bank of America, for example, the latest TPF version (TPF2) is the basis of a new on-line teller support system now under development.

FIG. 1

ESTIMATED OLTP MARKET SIZE

WORLDWIDE SHIPMENTS BY U.S. MFGS.—HW/SW/PERIPH (NO SERVICE) • ADJUSTED FOR CALENDAR YEAR • $ BIL.

	CY 1982	CY 1983	CY 1984	CY 1989
IBM	10.8	14.2	17.6	28.3
BUNCH & PCMs	5.5	6.5	7.9	12.7
Minis	2.2	3.1	4.7	9.4
FT Suppliers	0.3	0.4	0.5	1.8
Total	18.8	24.2	30.7	52.0

FT SUPPLIERS ($ MIL.)

	CY 1982	CY 1983	CY 1984	CY 1989
Tandem	310	387	474	1,390
Stratus	5.5	20	40	320
Others	—	—	5	50
Total	315	407	519	1,760

Source: ITOM International Co.

MASSIVE VOLUMES TYPICAL

The airline reservation application is characterized by massive amounts of disk data, a large number of terminals, and high transaction volumes. The TWA system, for example, which is the smallest of the big three noted above, runs on a 9083 system (a specially modified version of the 3083 mainframe), uses 144 300MB disk drives, supports some 12,000 terminals, and handles peak loads of over 200 messages per second. (A message, the basic transaction in this system, involves execution of about 20,000 to 25,000 instructions and more than nine DASD accesses.)

Telephony-related applications. At about the same time the airline reservations systems were being installed, AT&T in the U.S. and the PTT in France began installing computerized central office switches in their respective telephone systems. The computer in such systems is involved principally in call setup: it determines the routing for the call and creates a connection by setting parameters into the switching apparatus. It must be able to handle a large volume of such transactions, and must be highly available. In these respects, it is rather like an OLTP system.

This application is not typical OLTP, however, because it does not involve a database and it does not require the computer to remember contexts; an interrupted call is simply lost, and the parties must redial to establish a connection. Logging is used merely as the basis for billing. In contrast, an OLTP system must keep careful logs in order to be able to back out of transactions or roll forward the database. (Roll forward is explained later in this article.)

In the U.S., AT&T developed a series of fault tolerant (FT) processors for service in central office switching applications. The 3B20D is the latest in the series: it was first offered to the public in March 1984. One notable application with some OLTP flavor is the 800 calling system, which is serviced by a network of 3B20D computers. Here, toll-free numbers dialed by subscribers must first be translated to the correct area code and number of the destination.

The telephony-related application with the strongest OLTP character is the directory assistance support (DAS) system, supplied chiefly by Computer Consoles, Rochester, N.Y. This system allows multiple operators to retrieve telephone numbers by subscriber names or other keys. It offers high availability and fast response time by replicating the database up to eight times.

Banking and financial applications. Since the mid-1970s, banks have been installing OLTP systems at an increasing pace. The most visible of these systems support teller activities, which are principally concerned with demand/deposit (checking) and small savings accounts. Banks have been automating depositors' account handling and other aspects of their operations for at least 25 years now, but the complete on-line handling of account transactions is only now becoming the accepted norm.

For example, in 1977 the Bank of America installed a multiple minicomputer system to help 10,000 tellers in 1,200 branches administer 10 million customer accounts. In each of the bank's two processing centers (Los Angeles and San Francisco), a network of 32 minicomputers acts as a front end to large IBM mainframes, where account information is held. Every morning the account status is loaded into

The early OLTP systems for the first time allowed many users to concurrently access and update the same data.

the mini system; during the day, most teller transactions involving debits or credits to the accounts are merely captured on-line. At night, the transactions are processed in batch fashion by the main computers to update the account information. At this point the bank is engaged in a project that will replace this system with a more integrated one based on IBM's TPF2 software. Other, smaller banks have already implemented such integrated on-line teller support systems, some using Tandem equipment.

DEMANDS MORE SEVERE

In many ways, the demands of the financial OLTP environment are far more severe than other OLTP applications. There is a need to maintain absolute accuracy (in account balances, for example), despite concurrent update activities and, possibly, hardware failures.

The explosion in new customer services, including local, regional, and national ATM networks, is increasing the demand for OLTP systems in the banking industry. Such services are being spurred by increasing competition due to deregulation, as well as by the need to reduce costs (e.g., replacing manned branches with ATMs).

Manufacturing. Despite increasing use of computers in planning (manufacturing resource planning, or MRP) functions, much of the actual running of a discrete-process production plant is still paper-controlled and often characterized by batch-style operations, where blocks of raw materials are converted to end-products as a group.

Increasing attention is now being focused on shop floor control and other systems involved in the minute-by-minute operation of such plants. The concept of a paperless factory is rapidly gaining acceptance. In such factories, the paperwork accompanying each product or batch is replaced by a combination of bar-code stickers and information entered through terminals located in the various work areas. The systems supporting paperless factories are prime examples of the application of OLTP technique in the manufacturing environment.

Because of increasing concerns regarding industrial productivity, such systems have been funded more aggressively in the past few years, and are likely to continue to be the focus of substantial interest. These systems save time once lost to form filling; provide up-to-the-minute reports on the status of plant, inventories, and finished goods; and can be used to pinpoint sources of production problems earlier than before. The adoption of JIT inventory disciplines virtually mandates the use of on-line control systems.

Tandem Computers, the leading supplier of fault tolerant systems for OLTP service, is mounting a major campaign to place its systems in manufacturing applications. Tandem practices what it preaches: its plant in Austin, Texas, which manufactures the NonStop EXT computer and a variety of terminals, is one of the early examples of a paperless factory. Similar and related systems are being installed in other Tandem manufacturing plants.

In Austin, bar-code stickers attached to pc boards are used at the test stations to automatically download the appropriate test program. All of the tracking of materials flow, from receiving and stocking through processing and shipping, is based on bar-code identification at each work stage. (In the terminal products, the plant also employs innovative work disciplines, under which each worker is responsible for assembling a complete product, as well as for testing and reworking if necessary; there are no inspectors as such.) Naturally, the plant's control systems run on Tandem gear.

At Apple's famed Macintosh plant in Fremont, Calif., which tried to enforce the JIT discipline and originally utilized highly automated material movement systems (some of which have since been removed), a Tandem system now supports the key management information system. Although this system is not yet on-line, there is a plan to move in that direction. The plant employs a paperless rework facility based on an HP 1000 minicomputer.

Fault tolerance and availability. The spread of OLTP systems, beginning with the airline reservations systems, brought to the fore some concerns about the reliability of computer systems. Previously, computer downtime affected just a small number of back-room workers who were typically engaged in after-the-fact record-keeping.

OLTP AT HEART OF BUSINESS

By contrast, OLTP systems are frequently at the heart of the business; a disruption in system operation can forcibly idle many employees and possibly halt important services that customers rely on. An airline with an inoperative reservations system can't book new business; a bank with inoperative ATMs is antagonizing its customers.

The impetus for the development of commercial FT systems came chiefly from such concerns. (It should be added that in the mid-1960s, fault tolerance was also important in the space program, various military aerospace projects, and in the computerization of the telephone network in the U.S. and in France. These efforts were principally focused on cpu and memory redundancy techniques, however; they did not deal with database robustness or concurrency and consistency issues, and hence contributed only marginally to today's commercial FT systems for OLTP service.)

Some of the key ingredients of today's FT systems were first developed and tested in the airline reservations systems. Among these are disk mirroring, or shadowing, a scheme by which the system undertakes to maintain a mirror image of critical disk data by automatically replicating every write to a second, physically separate drive. This assures that the critical portions of the database are physically accessible even after a disk drive failure. This capability was implemented in early versions of IBM's ACP.

TRAVEL AGENTS' DILEMMA

The early OLTP systems for the first time allowed many users to concurrently access and update the same data. This focused attention on a new problem: how to assure data consistency in the face of concurrent updates. For example, if two travel agents wish, at about the same time, to book two different passengers on a given flight, they may both first read the current status (N seats available) and modify it by computing the new balance, N-1. Both write back this new balance, resulting in an inconsistent inventory: N-1 instead of N-2.

The most common solution for this type of problem is to serialize the concurrent accesses by means of file and record locks, also an early feature of ACP. Thus if the agent's transaction intends to modify the seat inventory, a lock is placed on the relevant flight record to prevent anyone else with similar update intent from reading the seat status until the first agent is through.

As it turns out, the airline reservations environment is not overly sensitive to this particular consistency issue, if for no other reason than the fact that airlines practice flight overbooking to counter no-shows. Data consistency became a key concern in the mid-1970s, when the banking and financial communities began implementing large-scale OLTP systems.

While in other OLTP systems slight variances between the computer's database and the real inventory situation, for example, are acceptable, in the banking environment such variances are intolerable. A bank can't tell a customer his current balance is approximately so many dollars; ex-

The explosion of new customer services is increasing the demand for OLTP systems in the banking industry.

actitude is of the essence.

How does one protect this exactness requirement in the face of possible computer failure? For example, suppose the system crashed in the middle of executing a transaction that takes money from one account and puts it into another. The database is now inconsistent, since the money is missing from the source account but isn't yet reflected in the recipient's account.

The concept of atomic transactions originated as a response to this and similar problems. Atomicity is a property of the system under which the user may define a sequence of related database actions (by, for example, bracketing the sequence with "BEGIN TRANSACTION" and "COMMIT" commands); the system undertakes to guarantee either that all such actions will be effected or that none will.

There are various ways to achieve this guarantee. Perhaps the most popular is the write-ahead log technique, in which the before and after images of the affected records are first written to a mirrored disk log file. If the system is successful in then implementing these changes in the actual database, a success record is added to the log file.

If the processor or the system crashes in the middle of such actions, the system can examine the log file upon being restarted; those transactions not successfully implemented (detected by the absence of the success record in log file) can be undone by using the before and after images. As long as one copy of the log file and the database remain intact, any number of system failures can be compensated for by repeating this transaction-backout process, which removes the effects of incomplete transactions.

Such facilities are now becoming common in most transaction-oriented systems. IBM's IMS and CICS have had them for a while, as has Tandem's Encompass, and Hewlett-Packard recently incorporated transaction backout in its Turboimage DBMS. But fault tolerant systems, which feature multiple processors, can perform such transaction backout actions essentially on-line, whereas a conventional uniprocessor system typically has to be manually restarted before attempting transaction backout.

Roll forward is a more drastic database recovery technique that is needed when the current on-line database is lost, because, for example, of a disk drive failure or double disk drive failure in mirrored disk situations. Here the system periodically dumps the database to an off-line tape; after a crash, the system can input the most recent dump, and use the log file to redo all the transactions that were successfully committed since that dump.

Tandem Computers, Cupertino, Calif., has been the premier supplier of FT systems for commerical OLTP applications since it began shipping some 10 years ago. The company quickly grew to become a Fortune 500 member, with revenues of over $600 million projected for the fiscal year ending September 1985. The Tandem multiprocessor system can restart failed processes through a checkpointing scheme and supports the full range of database integrity and consistency measures, including some that apply in distributed environments.

STRATUS ANOTHER SUCCESS

Stratus Computer, Marlboro, Mass., is another successful supplier of commercial FT systems. Launched in 1980 and still much smaller than Tandem in terms of revenues (projected to exceed $70 million in 1985), Stratus's growth rate will have averaged over 100% a year since shipments began in 1982. Furthermore, earlier this year, Stratus concluded an unprecedented agreement with IBM, under which the giant firm obtained the right to resell the Stratus system under its own logo. The program is still highly tentative; general availability from IBM will depend to a large extent on favorable reactions from a number of test sites. Regardless of the actual volume of shipments, though, the prestige of being the first computer supplier to IBM is valuable in itself.

While IBM's involvement with Stratus is interesting and significant, it is not nearly as fraught with strategic consequences as some analysts have suggested. IBM is a large, diverse organization, which in recent years has delegated more and more responsibilities to its various product divisions and adopted increasingly aggressive tactics. The Stratus agreement came about as a result of one such division's perception of what it needed to serve its customer base. There are some indications, however, that the Stratus move has served to focus attention on the issue of fault tolerance within IBM, and that the company is making some attempt to centralize at least the marketing and support functions for its diverse high-availablity efforts.

Some in IBM are not convinced that fault tolerant hardware is required for high availability. They have been claiming, for example, that some 308X installations have never experienced a TCM failure. (TCM, thermal conduction module, is the basic package of chips from which the 308X systems are built.) Field data collected by Reliability Research, Stamford, Conn., and reported in the author's *FT Systems* newsletter supports this claim, and indicates that IBM 308X cpus enjoy mean time between failures (MTBFs) of 1.9 to 3.4 years—substantially better than an Apple desktop micro. Nevertheless, customers evidently want more; in response, IBM plans to unveil in 1986 the extended reliability feature (XRF) for IMS. XRF is an enhancement to IMS that will allow two IMS-running systems to act as an on-line/hot backup pair, and to automatically switch roles on a failure in the on-line system.

A host of would-be FT suppliers, launched at about the same time as Stratus, have encountered substantial product development and financing problems (see "Fault Tolerant Blues," March 15, p. 82). Still, some are likely to survive and reach production status, although possibly not as independent entities.

Performance considerations. Measuring the performance of OLTP systems is important for both capacity planning and for comparing various vendors' offerings prior to procurement. Such comparisons have always been a subject of controversy even with conventional computer systems, and are even more difficult in the OLTP environment.

Whetstones, MFLOPS, and MIPS are not very meaningful in the OLTP environment. They tend to measure the raw cpu performance, completely ignoring the three most important factors that affect the performance of OLTP systems: system software capabilities, I/O efficiency, and the impact of communications protocols. They also do not properly reflect the capabilities of multiprocessor systems, which are especially popular in OLTP and FT applications.

MEASURING HOW OLTP PERFORMS

A much better measure of OLTP performance is the tps (transactions per second) rating. A number of OLTP system suppliers, including Tandem and Stratus, are now routinely reporting results of benchmarks in terms of tps. The difficulty is that just as there is no standard way to define an average instruction for a MIPS calculation, the average transaction is equally elusive. Yet the definition of what a transaction does is crucial if tps figures are to have any merit as comparative performance indexes.

For example, a transaction representing a bank withdrawal or deposit may involve four to six database accesses, some of which may require locking one or more records. With a teller and a customer waiting for a result, response time is obviously critical and must be factored in. In contrast, a transaction in, say, a gaming support system may involve pure logging; in

Data consistency became a key concern in the mid-1970s, when the financial community began implementing large-scale OLTP systems.

such an environment, many transactions could be logged to disk in one access. Clearly, tps figures from such widely differing applications are not comparable.

A notable first attempt to define a standard transaction benchmark has been described in DATAMATION ("A Measure of Transaction Processing Power," April 1, p. 112). That article is also notable in that it proposes a standard way to assign a cost factor to a tps, so that a user could actually make a meaningful tradeoff between performance and cost. The cost per tps for typical multiprocessor systems such as Tandem or Stratus runs about $50,000 to $100,000 per tps. Such systems can deliver about 1tps to 5tps per cpu under this benchmark. Large IBM mainframes can do perhaps 10 times better in terms of tps/cpu, but are not necessarily more cost-effective in terms of cost per tps. Unfortunately, not enough comparative data are yet available.

How many tps are enough? Much as batch systems gobble up MIPS, the OLTP market seems to have an insatiable appetite for higher tps capacities. A number of large customers, especially the airlines, financial institutions, and brokerage firms, already foresee the need for systems offering 1,000 or more tps. A key issue is whether architectures that rely on multiple low-powered processors can effectively serve such applications.

The reason for this concern is the well-known loss of performance due to multiprocessing overhead, which results in a less-than-linear performance increase as the number of processors is increased. Tandem, for one, is convinced that it can handle the task by locally interconnecting multiple systems of its top-of-the-line TXP multiprocessor over a fiber-optic network dubbed FOX. Preliminary benchmark results appear to support Tandem's claims that performance growth can be made nearly linear, both within TXP systems and across the FOX network.

IBM, on the other hand, appears to be placing its bets on TPF2 and large mainframes. While this combination is indeed capable of supporting high transaction rates, its chief weaknesses, as pointed out by competitors, are that it provides only rudimentary database facilities, requires the user to implement system services and applications in assembly language, and generally requires substantial customization and support.

Both approaches are likely to find favor for a while. Applications requiring very high transaction rates will continue to have to sacrifice functionality (i.e., a wide variety of file types and access methods) for performance. As hardware costs continue to plummet, and as basic system performance continues to improve, we will probably see high-functionality systems, such as IBM's IMS or Tandems' Encompass, begin to approach the high transaction rates currently possible only with highly tuned, minimum functionality systems. ◉

Omri Serlin heads ITOM International Co., a research and consulting firm in Los Altos, Calif. He is preparing a book on on-line transaction processing systems, to be published by Prentice Hall. He also writes the *FT Systems* newsletter, which reports and analyzes developments in OLTP and fault-tolerant systems.

We want to take heart defects out of the nursery.

It almost breaks your heart to see it. She's two days old and there's a question about a hole in her heart. She's fortunate. Something can be done about it. Each year, 25,000 infants are born with heart defects which can disable them for life.

The American Heart Association is fighting to reduce this form of early death and disability with research, professional and public education, and community service programs.

But more needs to be done.

You can help us save young lives by sending your dollars today to your local Heart Association, listed in your telephone directory.

Put your money where your Heart is.

American Heart Association

WE'RE FIGHTING FOR YOUR LIFE